Characterization of Upper Saginaw River Turning Basins as Sediment Traps

Background

Studies conducted in 2004 by Dow (CH2MH), MDEQ, and the U.S. Army Corp of Engineers (USACE) in the Saginaw River identified significantly elevated concentrations of dioxin in the sediments of the Upper Saginaw River, primarily in the non-navigational portion of the river from Green Point to the Sixth Street Turning Basin. Core sampling and congener profiles indicated that the Tittabawassee River is a source of this contamination to the Upper Saginaw River.

In this area of the Upper Saginaw River, two navigational turning basins exist. The Ojibway Island (Ojibway) Turning Basin is located 3 miles south of the confluence with the Tittabawassee River. Ojibway was abandoned over 20 years ago and has an estimated 75,000 cubic yards of sediment. The Sixth Street Turning Basin (Sixth Street), downstream of the City of Saginaw, is the current terminus of commercial navigational dredging, and was recently dredged of approximately 100,000 cubic yards of sediments in October 2006.

The Ojibway and Sixth Street Turning Basins present an opportunity to conduct studies of sediment depositional behavior in the Upper Saginaw River. Rate of settling, composition of settled material, and dioxin contaminant levels, from a historical (buried) and recent (surficial) perspective, are important components for evaluating whether sediment traps could be an effective measure in capturing sediments and associated contamination.

Study Context

A Technical Workgroup with scientists representing numerous state and federal agencies, the Saginaw Chippewa Indian Tribe, and Dow, were assigned the task of designing an initial pilot study in the Saginaw River to answer critical questions concerning the use of sediment traps to capture and remove sediments and associated dioxin and furans.

Under the guidance of the Technical Workgroup, Dow Consultant, ENVIRON International Corporation, drafted, "The Characterization of Sediments in the Ojibway Turning Basin (Study 1)", and "Sediment Trap Field Performance and Feasibility Study in the Saginaw River Sixth Street Turning Basin (Study 2)". The MDEQ, USEPA, and Dow, as well as the state, federal and tribal agencies, serving as trustees for natural resources of the river and bay, supported the proposed studies. Dow has agreed to fund the implementation of these workplans. The two studies will begin in November of this year (2006) and continue through 2007. The studies will incorporate additional information (i.e. geochemistry) that may become available from other studies that are ongoing.

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STUDY 1:

CHARACTERIZATION OF SEDIMENTS IN THE OJIBWAY TURNING BASIN FIELD SAMPLING AND ANALYSIS PLAN

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1. INTRODUCTION

The SAP describes field and supporting laboratory work to characterize historical sediment deposits in the Saginaw River, Michigan. This SAP describes the first of 2 studies scheduled for implementation commencing October-December 2006 through December 2007. The two studies are as follows:

Study #1. Characterization of Sediments in the Ojibway Turning Basin
Study #2. Sediment Trap Performance and Feasibility Study

The primary goal of both studies is to assess the long-term performance and feasibility of a pilot-scale field sediment traps in the Saginaw River, Michigan (Figure 1, Site Map). The recent (August-September 2006) dredging of the Sixth Street Turning Basin provides a unique opportunity to evaluate the performance and feasibility of a pilot-scale sediment trap in the Saginaw River, while evaluating historical sediment deposits in the historically dredged Ojibway Island Turning Basin.

1.1 STUDY #1 - CHARACTERIZATION OF SEDIMENTS IN THE OJIBWAY TURNING BASIN

The goals of Study #1 are to characterize dioxin/furan (D/F) concentrations in historical sediment deposits and to correlate the distribution of congeners at different depths (if possible) with physical or chemical sediment characteristics, such as particle size distribution (PSD), organic carbon content, black carbon content, bulk density, and/or mineralogy. This study will supplement ongoing geomorphological studies measuring D/F concentrations among different morphological features (e.g., levees, wetlands, floodplain soils, and river terraces) to better understand the distribution of D/F in soil and sediment samples and to correlate (if possible) relationships between D/F concentrations and river morphology.

The study will be conducted in two phases. Phase 1 will include sediment coring, vertical segmenting of sediment cores, analysis of bulk D/F concentrations, and analyses of bulk PSD, organic carbon, black carbon, and mineralogy. Phase 2 will include sediment fractionation studies using a subset of the bulk samples.

Ongoing D/F fractionation protocols developed by Dow's Environmental Chemistry group will be applied to a subset of sediment samples collected during Phase 1. The fractionation analytical approach is currently under development by Dow using floodplain soil samples, and is described in Appendix G of the *Geomorph Sampling and Analysis Plan* (ATS 2006). The approach involves fractionating samples into sand (53-2000 μm), silt (5-53 μm), and clay (<5 μm) size fractions and analyzing those size fractions for D/F, TOC, black carbon, and mineralogy.

The expected outcome of Study #1 includes the following:

- Collection of empirical data on the distribution and capture of D/F in historically deposited sediments at the Ojibway Island turning basin, and an understanding of the deposition and layering characteristics (e.g., size of particles and mass of contaminants) that a potential sediment trap may exhibit in the Upper Saginaw River over time.
- Assessment of how D/F congener distributions and total D/F concentrations in sediment deposits may have changed over the past 20 years.
- Characterization of the morphological distribution of deposited sediments, including grain size and organ carbon content, and a comparison of these morphological characteristics with other reaches of the river based on the *GeoMorph* results.
- Application of D/F fractionation methods to river sediments by Dow's Environmental Chemistry Group to better understand D/F distribution based on sediment grain size and sediment morphology, develop a better understanding of mechanistic sorption processes, and quantify desorption rates.

1.2 STUDY #2 - SEDIMENT TRAP PERFORMANCE AND FEASIBILITY STUDY

The goal of Study #2 is to implement a mass balance evaluation by measuring river transport velocities, cross sectional areas, suspended solids loads, and D/F concentrations on the suspended solids under a variety of flow conditions, including low and high flow periods that occur during different seasons. A simplified conceptual model of the sediment mass balance study is shown in Figure 2 (conceptual diagram). The conceptual model also should recognize varying solids loads, sediment deposition, burial, resuspension, and transport rates in the Saginaw River as distinct elements of the mass balance. Though not illustrated in Figure 2, the conceptual model also should recognize the dynamic nature of the mass balance based on dynamic flow and solids transport conditions. Flows and solids loads will differ during the rising limb and the falling limb of a wet weather event, for example.

Several measurement techniques will be used to establish flow velocities and suspended solids concentrations in the river. The mass balance study will be supplemented by bathymetry measurements and surface sediment sample collection in the turning basin sediment trap to measure sediment accumulation in the trap over time. A preliminary mass balance study will be conducted at the existing Sixth Street Turning Basin, which underwent limited emergency dredging in August-September 2006.

The expected outcome of Study #2 includes the following:

- Measurement of sediment and D/F mass entering and exiting a pilot-scale sediment trap.
- Quantification of sediment and D/F mass deposition in a pilot-scale sediment trap.
- Assessment of the performance and feasibility of a pilot-scale sediment trap to capture and trap suspended solids and D/F mass in a dredged turning basin.
- Collection of information needed to establish performance criteria for design of a pilot-scale sediment trap.
- Collection of information needed to scale up and design a full-scale sediment trap for long-term river maintenance.

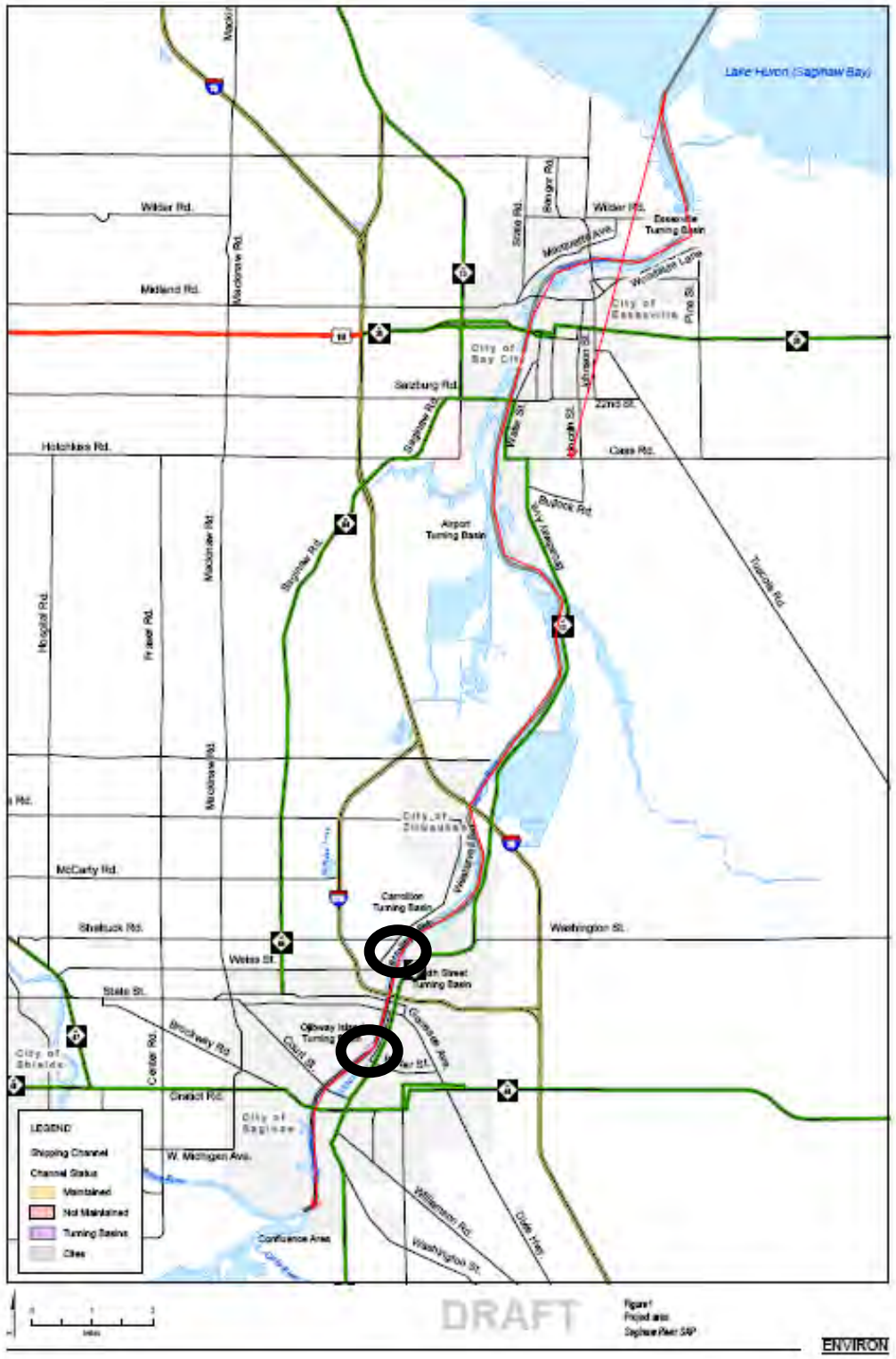

Figure 1. Saginaw River, showing Sixth St. Turning Basin (SSTB) and Ojibway Island Turning Basin locations in the City of Saginaw.

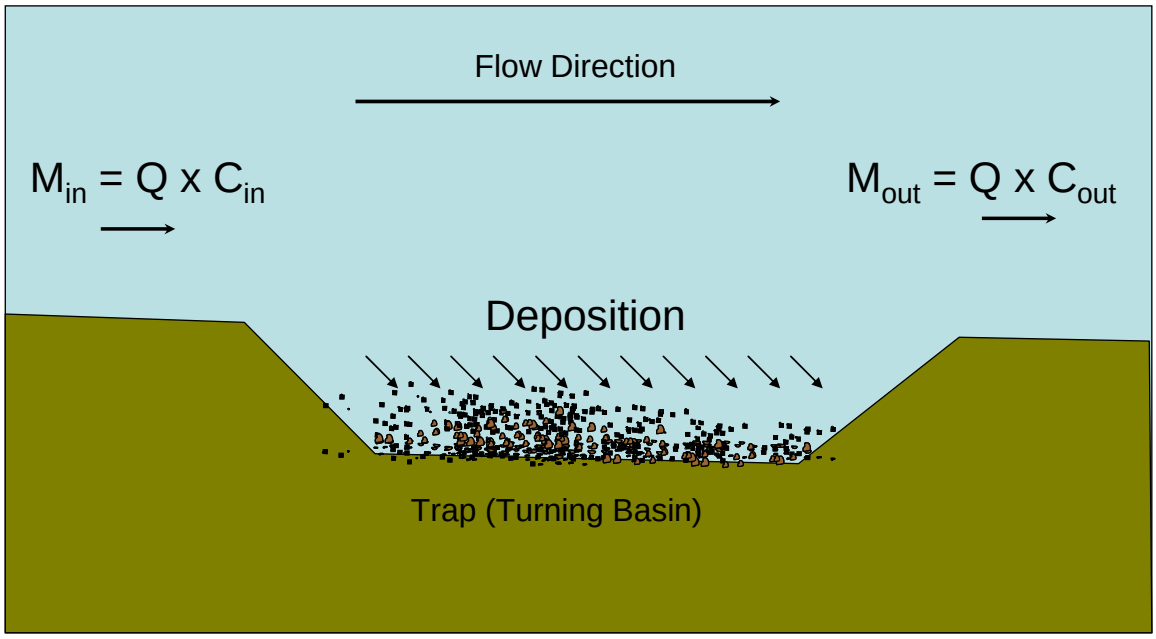

Figure 2. Sediment Mass Balance Study Conceptual Model.

2. STUDY #1 OVERVIEW

2.1 DESCRIPTION OF STUDY AREA

The Ojibway Island Turning Basin is located in the former navigational channel of the Upper Saginaw River, approximately 3 miles south of the confluence of the Tittabawassee and Shiawassee Rivers (Green Point), at river mile 19.2 from the mouth of the Saginaw River. As a turning basin, it has not been dredged for approximately 20 years (Art Ostaszewski, MDEQ-WHMD, estimate), since the terminus of navigation was moved downstream to the Sixth Street Turning Basin, located at river mile 17.5.

The Ojibway Island Turning Basin presents a unique opportunity to examine the characteristics of large-scale sediment deposition in the Upper Saginaw River. Originally excavated bank to bank to a surface area of 600 x 650ft, the basin has completely silted in since the last time it was dredged. Depth in the basin now ranges from 0 ft with emergent vegetation, to ~15 ft depth (Figure 3, from CH2MHill).

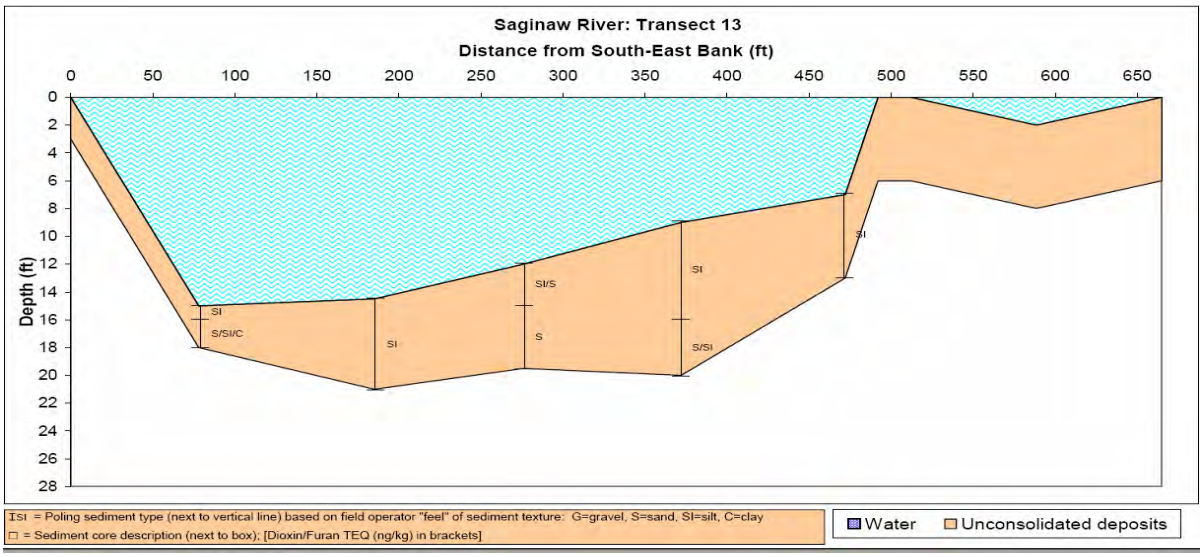

Figure 3. Saginaw River Sediment Profile, at the Ojibway Island Turning Basin.

2.2 OVERVIEW OF FIELD ACTIVITIES

The field work described in this SAP addresses sediment investigations in the Ojibway Island Turning Basin, plus additional sediment sampling in the Saginaw River. Five tasks have been identified for this study and are discussed in Section 4.0.

The 5 tasks planned for the field investigation are:

- Task 1 – Sediment coring and vertical segmenting of sediment cores for chemical and physical characterization
- Task 2 – Physical characterization of sediment samples, including particle size distribution, total organic carbon, black carbon, bulk density, and mineralogy
- Task 3 – D/F characterization of sediment samples
- Task 4 – Fractionation analyses
- Task 5 – Data analysis and reporting

3. FIELD PROCEDURES

3.1 MOBILIZATION/DEMOBILIZATION

Pre-mobilization activities include subcontractor selection and contracting, equipment specification and procurement, and staffing and task planning. Mobilization of equipment and personnel for field sampling will be undertaken prior to commencement of field sampling activities. Personnel, supplies, equipment, and subcontractors will be mobilized and demobilized to and from the Site as necessary for completion of investigation tasks. Equipment leaving the Site may require decontamination prior to departure in accordance with the specific SOP. Appropriate agencies (e.g., US Coast Guard, US Army Corps of Engineers, and Michigan

Department of Environmental Protection) and the public will be notified as needed prior to mobilization.

3.2 SITE FACILITIES

A location for the storage and staging of equipment and land-based vehicles during the field investigation and for segmenting cores and sample packaging will be maintained. This location will include a decontamination area, a sample handling and preparation facility, and a storage facility. Access to this location will be strictly controlled. No one shall enter the area without appropriate authorization and health and safety training. Watercraft vessels will be moored at an appropriate nearby marina or docking area.

3.3 HEALTH AND SAFETY

Health and safety requirements applicable to all persons entering the secured location or involved in field activities on the Saginaw River will be described in a separate Health and Safety Plan (HASP).

3.4 TECHNICAL SUPPORT

Field work will be conducted or contracted for and supervised by ENVIRON. Work is anticipated to require a 4-person field team, including a boat captain and 3 field technicians for sample collection, health and safety, handling/processing, and recordkeeping of all aspects of the field work.

4. FIELD TASKS

4.1 TASK 1 – SEDIMENT CORING AND SEGMENTING

Field sampling activities include collection and segmenting sediment cores for chemical and physical analyses. Sediment cores will be collected from 8 (tentative) locations within the turning basin. Locations are shown in Figure 4 (sample locations), and include near shore and mid-river.

Sediment cores will be collected using a vibratory coring device (or other appropriate device) with an aluminum casing lined with transparent liners (e.g., Lexan, clear PVC, or polybutyrate) for core extraction. The collection of sediment cores will be conducted from a vessel equipped with an A-frame or similar deployment system to lower and retrieve the vibracoring unit. The coring contractor will be informed of the relatively sandy nature of Saginaw River sediments, and will be asked to ensure that the coring equipment mobilized for this study is appropriate for sandy sediments.

Upon completion of sediment penetration, the vibracoring device will be returned to the deck of the vessel and the core tube, containing the core liner and recovered sediment, removed to a core extraction table. The core liner will be extruded from the aluminum casing, sectioned only if necessary for safety and handling purposes, with each segment capped at both ends, marked with

regard to the top and bottom of the core, and labeled. The sediment core will be maintained in an upright and fixed position on the vessel until transferred onshore for sediment core processing.

Upon collection, the following information will be logged for each core:

- Date and time of core
- Station GPS coordinates (latitude and longitude)
- Water depth at the time of sample collection
- Sediment core recovery length
- Assessment of whether the core hit refusal

All equipment will be rinsed using river water prior to each use. Factory core liners will be uncontaminated, or decontaminated prior to use.

At the onshore staging area where sediment cores will be processed, each core will be laid horizontally and split lengthwise to create two parallel halves. Cores will be measured, photographed, and logged according to standard visual geotechnical descriptions, such as general grain size (sandy, silty, clayey), color, and other indicators of appearance.

Cores will be segmented into 15-cm intervals, or according to observed morphological features, so that sediment samples capture unique visible morphological features observed in the sediment cores. Visible morphological features may include visible changes in grain size distribution, color, organic carbon content, or layers of natural or anthropogenic debris, for example.

Sediment composites will be collected from each sample interval and prepared for off-site storage or laboratory analyses for physical and chemical parameters. Sediment composites will not exceed 15 cm, and to the extent possible will not overlap adjoining visual morphological features. Initially, 5 segments will be analyzed from each core for physical and chemical parameters. The remaining segments will be stored at 4ºC (not frozen) for future analyses, depending on the initial analytical results.

Sediments sent to the laboratory for chemical analysis will be collected from the center portions of each core so that sediment in contact the core liner will not be included in samples sent to the laboratory for chemical analysis. This is to minimize the possibility that material may smear along the core sidewall during coring, which would potentially confound the interpretation of conditions at the targeted depth interval. Samples will be collected using uncontaminated disposable spoons (e.g., wooden or plastic) or decontaminated reusable spoons.

Qualified laboratories will perform the physical analyses (e.g., PSD, TOC, black carbon, and bulk density). Alta Analytical Laboratory will perform D/F analyses. The sample volumes will depend on the mass requirements for each of the respective analyses. Separate sample containers and chain of custody forms will be used for separate labs designated for analyses. Fractionation, partitioning, and mineralogy studies are discussed in Section 4.4 and will be performed by Dow's Environmental Chemistry Group.

4.2 TASK 2 –PHYSICAL CHARACTERIZATION

Table 4.1 shows analytical methods and Quality Control (QC) requirements for physical characterization of sediments. Physical measurements will be determined in all sediment samples (approximately 40 samples, representing 5 samples from each of 8 cores).

Table 4.1. Analytical Methods and Quality Control (QC) Requirements.

Analysis	Method	Laboratory	Holding	Packaging	Sample mass / volume
PSD	ASTM D422	TBD	6 mo., chill: 4º±2º	8-oz plastic	150 g
TOC	EPA Method 9060A	TBD	28 d., chill: 4º±2º	8-oz plastic	10 g
Black Carbon	Gustavson et al., 1997	TBD	28 d., chill: 4º±2º	8-oz plastic	10 g
Bulk Density	ASTM 2937	TBD	6 mo., chill: 4º±2º	8-oz plastic	50 g

Gustavson, et. al., 1997. *Environ. Sci. Technol*., 31:203-209.

4.3 TASK 3 – D/F CHARACTERIZATION

All sediment samples (approximately 40 samples, representing 5 samples from each of 8 cores) will be analyzed for dioxins and furans. Two analytical methods (Method 1613-TRP/RT and Method 1613B) will be used D/F analyses. Method 1613-TRP/RT refers to Dow's *Rapid Turnaround Analysis,* which modifies Method 1613B by using a subset of site-specific D/F congeners that represent the dominant fraction (more than 90%) of D/F mass in the Saginaw River. Method 1613B analyzes for all 17 2,3,7,8-substituted D/F congeners. Sample extraction, including internal/surrogate standards, is identical for both methods. Both methods are described in detail in the *GeoMorph SAP* (ATS, 2006) and are included in this SAP by reference. Method 1613-TRP/RT measures the following D/F congeners:

- 2,3,7,8-TCDF
- 2,3,7,8-TCDD
- 1,2,3,7,8-PeCDF
- 2,3,4,7,8-PeCDF
- 1,2,3,4,7,8-HxCDF + 1,2,3,6,7,8-HxCDF

All samples will be analyzed using Method 1613-TRP/RT. Sample extracts will be stored for further analysis pending D/F concentration results. A subset (10%) of the sample extracts will be analyzed for the full suite of 17 2,3,7,8-substituted D/F congeners using Method 1613B. The samples will be selected based on concentration, vertical D/F distributions in the sediment cores, and to match samples identified for the fractionation study.

4.4 TASK 4 – FRACTIONATION ANLYSIS

The fractionation analysis is described in Appendix G of the *GeoMorph SAP* (ATS, 2006). Method development is in progress by Dow and may be subject to changes as the protocol is finalized.

A subset of the sediment samples (10%, representing 4 of 40 samples) will be fractionated and characterized according to protocols described in Appendix G of the *GeoMorph SAP* (ATS, 2006). Samples will be sent to Dr. John Davis at Dow's Environmental Chemistry Group, who will lead the studies. The following approach will be used:

- Sediment sampling will be segregated into three grain sizes using an hydrometer:
  - Sand: 53 - 2000 μm
  - Silt: 5 - 53 μm
  - Clay: <5 μm

Each size fraction will be analyzed for D/F concentrations, organic carbon and black carbon, and PSD. Correlations between D/F and PSD, organic carbon, or black carbon will be analyzed statistically. Further characterization will be conducted pending the results, including partitioning studies, mineralogy, and petrography. Samples slated for these studies will be identified and selected pending the results of the fractionation studies.

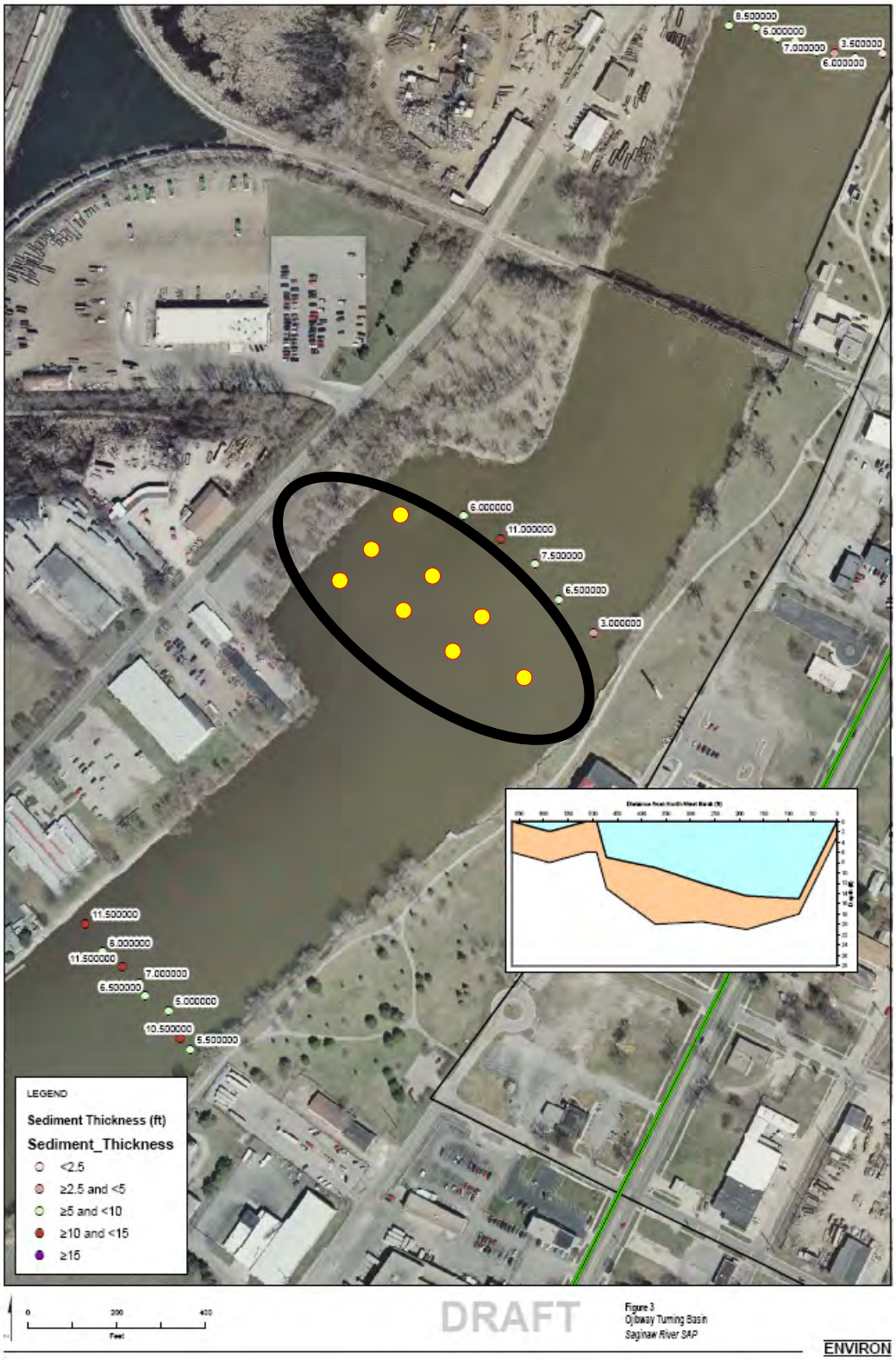

Figure 4. Proposed Sampling Locations.

5.0 DATA MANAGEMENT

Unique sample identification codes will be assigned to each sediment core location and to each discrete sediment sample. Sediment cores and samples will be documented and tracked using appropriate chain-of-custody procedures. Samples will be tracked from collection to final disposal.

Sampling and analytical/physical testing records will be maintained by the ENVIRON project manager. Electronic copies of field notes will be generated to establish a permanent record.

Validated chemical analytical data will be entered into a project database. Field, analytical, and other data will be stored in the project files in hard copy form, in accordance with ENVIRON's document retention and handling policy.

Each data package received from the laboratory will be validated to assess compliance with the appropriate Quality Assurance Project Plan (QAPP). A QA review report will be prepared as part of data validation describing any lapses in established protocols or accepted QC parameters and the potential data quality impacts. Data qualification "flags" will be applied by the laboratory for data that do not meet quality criteria.

6.0 REPORTING

ENVIRON will prepare a summary report of the data and findings. This report will include all data, QA/QC results, data summaries, and statistical analyses. The report also will include a narrative that will discuss field methods, the study findings, and their potential impact on the Sediment Trap Performance and Feasibility Study (Study #2).